DOCUMENT RESUME

ED 262 898 PS 015 413

AUTHOR Levin, James A.
TITLE Computers as Media for Communication: Learning and Development in a Whole Earth Context.
PUB DATE 8 Jun 85
NOTE 15p.; Paper presented at the Annual Symposium of the Jean Piaget Society (15th, Philadelphia, PA, June 6-8, 1985).
PUB TYPE Reports - Descriptive (141)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Computer Oriented Programs; Elementary Secondary Education; Foreign Countries; Global Approach; *Learning Activities; *Microcomputers; *Networks; News Writing; *Problem Solving; Rural Schools; Science Projects; Social Sciences; Student Projects; Student Research; *Telecommunications; Urban Schools

ABSTRACT

Educationally successful electronic network activities involving microcomputers and long-distance networks include a student newswire, joint social science projects, and joint science projects. A newswire activity, such as "The Computer Chronicles," can provide a wide range of audiences for writing, a functional environment for reading, and a context for evaluating the writing of oneself and others. Joint social science projects carried out by middle and high school students and teachers at sites in California, Israel, Japan, Alaska, and Mexico have involved students in comparing educational systems across sites, analyzing the news coverage of the "same" event at the different sites, and surveying popular music at the different locations. Joint science projects currently are being organized in which students collect data on some shared problem, jointly analyze the data, and report findings. Not only is this a "functional learning environment" for science instruction, but it also may be a powerful way to teach problem solving. In the longer run, these kinds of joint activities can become a central part of the educational experience. The dynamic support provided by computers and computer networks may make it economically feasible to include an "apprenticeship" model for learning as a central part of our educational system. (RH)

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ED262898

Computers as Media for Communication

Learning and Development in a Whole Earth Context

James A. Levin

Interactive Technology Laboratory

University of California, San Diego

La Jolla, CA 92093

Paper presented at the Fifteenth Annual Symposium of the

Jean Piaget Society

Philadephia, PA

June 8, 1985

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Acknowledgements

Many of the ideas in this paper reflect the collective work of the InterCultural Learning Network participants. I would like to acknowledge in particular the contributions of the various InterCultural network coordinators: Moshe Cohen (Jerusalem, Israel), Naomi Miyake (Tokyo, Japan), Dick Dauenhauer (Juneau, Alaska), Margaret Riel, Marcia Boruta, Bud Mehan, Randall Souviney and Gloria Fimbres (San Diego). The equipment for all the sites of the network was provided by a grant from the Apple Education Affairs Foundation.

In this paper, I want to describe some work we have been doing to develop new contexts for education, using microcomputers and long-distance networks. By now, almost everyone is aware of the potential the microcomputer has for changing education. However, along with the highly publicized development of microcomputers, there has been a less publicized change in our communication environment, one which I didn't see until I travelled to an Alaskan bush village.

Everyone has seen the home satellite dishes sprouting up in back yards, on roofs, even on balconies of apartment buildings. Several years ago, I travelled to a remote Alaskan village, crossing the Alaskan Range by prop plane, landing on a dusty runway. After being struck by the strange and wonderful sights of an Alaskan bush village, I saw the satellite dish, sitting unobtrusively behind the village center. This incongruous sight brought home to me how communication satellites have changed the influence that distance has on cost of communication. The cost for me to call from San Diego to that rural Alaskan village is just about the same as the cost of a call from San Diego to San Francisco. How can this be? Well, once your telephone call is routed up to a communication satellite 23,000 miles in orbit and then back down again, it really doesn't matter if it comes down a hundred miles away or a thousand miles away, at least as far as how much it costs to do it.

What does this have to do with learning and development? Well, in that Alaskan village is a school which has several microcomputers. When the teachers in that school use a little black box (a modem) to hook up one of the microcomputers to the village telephone line, then suddenly that remote

Alaskan classroom goes from being in an information-scarce environment to being hooked into some of the most advanced information systems the western world has developed. During the rest of this paper, I will describe a number of educational activities that we have created as a way of exploring the properties of this new interactive instructional medium. Then I will discuss some of the potentially important directions that these activities point toward for learning and development.

The first use that teachers often see for computer networks is to use them as access paths to various information bases. When I was demonstrating such a system (The Source) to a group of teachers in Alaska, a previously passive Eskimo sitting along the side perked up when he heard that you could access the latest gold price quotes. "Type 'gold'", he said, and when we did, we saw the latest gold quotes from London, New York, and Zurich. "Great", he said, "now I can check the gold prices each day when I'm back in Nome, and when they're high enough, I'll go out and work my uncle's gold claim." However, this new medium is more than just an electronic newspaper. While the access to new information bases is nice, it doesn't make a qualitative difference for education. It's like having a new set of reference books in the library: helpful occasionally but not a critical difference.

Another metaphor for its use is "electronic mail": it can be used for person to person communication. A person can type a message to another person, who can read it at some later time when he or she checks the same electronic mail system. These kinds of systems have been around for years, yet haven't had a significant impact on education. Why would we expect them

to be useful now? While the cost of communication has become relatively independent of distance, it still remains substantial, as you can all testify from your monthly telephone bills. What makes a difference here is the widespread availability of microcomputers. With a microcomputer in a school, students and teachers can type and edit their messages, and only when they are ready, connect to some distant computer to send the message. Thus, the communication cost is minimized.

With this new electronic mail medium, what do students and teachers communicate about?

> My new friend in Alaska I wanted to tell that if you wanted to be my friend and I be your friend.I go to the school of Balboa. And we have pet rats and we help them to do like triks so they could learn and be experts in triks and we have centers like art and all those things. But tell me are you sure you are going to be my friend I have another friend next to me she is a girl her name is Olivia she told me tell you if it is cold over there because here in San Diego its hot.Because here where we live its hot some times its rainy some times its cold well Bye,bye write back soon.

Dear Olivia and some body,

> My name is Betty Jean . We are Eskimos. It is cold here. We wear parka and Mukluks. We have dogs 15 of them. I have four of them. We catch fish with a net. We cut tree for our wood. so we wont get cold. We eat caribou and beaver and seal oil and dried fish.
> that is all
>
> love Betty Jean

Beyond Electronic Penpals. Many of the initial electronic mail messages between classrooms we have seen take the form of "electronic penpal" exchanges. While this is a good start-up activity, it is difficult

both to maintain and to integrate into the rest of the curriculum. Students generate messages like the ones above (written by two third graders in an urban school in San Diego, and by a student in a remote village above the Arctic Circle in Alaska) with great excitement. But the excitement doesn't last for long.

Since the messages are sent electronically, the students know the messages get to Alaska or San Diego almost immediately. However, when days go by with no response, the motivation wanes. To understand why responses are delayed, the students would have to take the point of view of the other school. A set of 30 messages arrive in Alaska, somewhat overwhelming the classroom which might have only 7 students. The teacher has to print out the messages, distribute them to students, and then organize times for the students to get on the computer to generate responses. The whole process might take several weeks. Finally, when the set of electronic responses arrive back in San Diego, those students that get responses are excited, but those that don't are disappointed and don't want to participate further. Once the messages are read once, there is little motivation to reread them. In this way, the electronic penpal activity has a limited utility in an educational setting.

Electronic newswires. Another electronic network educational activity that has been more successful is a student newswire. For example, we have been coordinating The Computer Chronicles over the past three years (Riel, 1985; Levin, Riel, Rowe & Boruta, 1985). This is an electronic newswire interconnecting classrooms in schools around the world from grades 3 through high school. Students at each site write newspaper articles that are sent to

all the other sites, and then students at each of the sites put together their own editions of the Computer Chronicles, selecting from those written at that site and those that have come in over the newswire.

Here is a typical article, written for the "Food" section:

(Kake High School, Kake, Alaska,4/18/85)

From the Kitchen of Alaska History Class

Soap Berry Dessert

A dessert sometimes enjoyed in Southeast Alaska is Soap Berry Dessert. Soap Berries, sugar, and cherry Kool-aid are the only ingredients for a smooth and creamy bitter-sweet dessert. First you place the berries in a bowl and beat with an electric mixer until smooth and frothy. Then you slowly mix in the sugar and kool-aid, mixing and beating until the mixture is homogeneous and very fluffy. It is eaten as a dessert when whenever soap berries are available, fresh or frozen.

By Dan

There are several ways in which this newswire activity can be integrated into the educational environment. First it is a way of providing a wide range of audiences for writing. The challenge of writing an article that is likely to get published in the editions put together in other sites is much more motivating for writing than simply sending a penpal letter.

Similarly, it provides a functional environment for reading, since the articles that come in have to be carefully read to help decide which to include in the local edition. A critical approach to evaluating text developed in the context of evaluating the writing of others can carry over

to evaluation of one's own writing (Riel, 1985). Students who were satisfied with the content and form of an article they had written changed their minds after sitting on an editorial board and criticising articles from elsewhere because they lacked details. In one case, the authors suddenly withdrew their "perfect" article from the pool of articles and rushed over to the computer to rewrite it.

Joint social science projects. More recently, we have been exploring educational activities conducted via electronic networks in other domains. During the past year, we have been coordinating a set of joint social science activities, run jointly by faculty and students at UCSD and at Lincoln Middle School in Vista California, at the Hebrew University of Jerusalem Israel, at the Aoyama Gakuin Woman's College in Tokyo Japan, at the Sealaska Heritage Foundation in Juneau Alaska, and at the Academia Ra-Sal in Tijuana Mexico (Cohen, Levin, & Riel, 1985; Cohen & Miyake, 1985). People in each site have generated projects, which were pilot tested across the sites and then jointly carried out by high school and middle school students and teachers in the different sites.

Ongoing projects include a study of career aspirations at each site, a comparison of educational systems across sites, an analysis of the news coverage of the "same" event at the different sites, and a survey of popular music at the different places.

For example, as part of the news analysis project, students at each site collected the headlines from the local newspaper that dealt with the 40th anniversary of the end of World War II during a ten day period in May. These

headlines were sent to all the other sites, and now form the basis of a discussion of why the "same" news event is covered very differently in each of the different sites.

Joint science projects. We are now starting to develop a number of joint science projects, in which students in each site collect data that bears on some shared problem, and then jointly analyze and write up a report of that data (Levin & Cohen, 1985). For example, we plan to have students at the different sites tackle the problem of water shortage. To do this, students at each site will trace out the water cycle at their site. Each site that faces this problem will have ways to collect water, to distribute it efficiently, to recycle it, to dispose of it. Once these descriptions have been shared between the sites, then the focus of the project will be for each site to analyze the techniques used by the other sites, and for those that are different, to understand either why they can't be used in their site or to discover that the technique is in fact useful at their location. This opportunity for creative discovery is a real one, because students are given techniques that actually work at other sites, and therefore techniques that are at least plausible. The students are also "experts" on their own setting, and will know many of the constraints on the local setting that an outside "expert" might be oblivious to.

These analyses of the problem can then be shared across the sites, and more details on techniques used at other sites can be exchanged. Then the students can jointly write up the results of their joint science project, and share their results in an electronic science fair, publishing their report in

an electronic science journal.

Not only is this a "functional learning environment" for science instruction, but it also may be a powerful way to teach problem solving. Such "instructional problem solving networks" involve students in joint interaction that is more characteristic of problem solving that adults do outside of school than much of the current school based problem solving. And problem solving by groups joined by electronic networks is likely to be a much more common mode in the near future.

Transfer of problem solving skills. A central problem in problem solving instruction is the problem of "transfer" (Gick & Holyoak, 1980; Pea & Kurland, 1984). The activity described above is designed to foster transfer. The first way in which transfer is fostered is by making what is usually "far transfer" into "near transfer". That is, network activities can be much more similar to the kinds of activities that adult problem solvers function in than usual classroom activities. This is a kind of "finesse" to the transfer issue: we make the instructional setting as much like the target setting as possible.

Another way that we can deal with the transfer issue is to involve students in explicit attempts to transfer. In the Water Project described above, students are involved in an effort we call "receiver site transfer". This concept is best understood in contrast to the common mode by which ideas are "transferred" by experts. When an expert goes into a setting, the underlying message is "here is what I do; you should do it". In a receiver-site transfer arrangement, the message is "here is what they do; maybe we should do it". That is, the design of the "water project" described above

is for each site to describe the techniques they use to deal with a problem, exchange these, and then analyse the techniques from the other sites to see whether they can be used locally. Since the techniques are actually used elsewhere, that gives them at least a surface plausibility. But since the sites differ, there will be many possible reasons why a technique used elsewhere may not work in a given site. The process of identifying these reasons is valuable, and in a small number of cases, students will transfer over techniques that adults in their own site find valuable.

Education on the Electronic Frontier

In the longer run, these kinds of joint activities can grow to become a central part of the educational experience. Students and teachers can participate in a number of these distributed activities, tackling interesting issues while at the same time learning about a particular domain.

Typically, our educational system teaches a subject by breaking it up into pieces and teaching students the smallest pieces first, then "assembling" those basic pieces into larger concepts, and then finally presenting the advanced student with the "big picture". This is not the only way to teach a subject. For a contrast, let us look at the "apprenticeship" model for learning. An apprentice who begins to work in a tailor shop, for instance (Lave,1977), spends his time in a real tailor shop, where he observes the whole process of making and repairing clothes. He is given simple tasks to do, but sees those tasks in the context of the whole activity, not as exercises isolated from any overall context. As the novice

acquires skills, he is given more and more complex tasks, until he has mastery of the whole domain of tailoring.

In an apprenticeship setting, the apprentice is given simple tasks within the overall context of the activity. These simple tasks are seen by the apprentice as "functional learning activities", since the relation between them and the overall activity is clear. In the setting, the apprentice receives "dynamic support" (Riel, Levin, & Miller-Souviney, 1985), being given only simple tasks to start, with the rest of the activity in the domain carried by the others in that setting, and then the learner takes over more and more of the task until mastery is achieved.

This kind of learning environment is very expensive to run if the dynamic support is provided by working adults in the community. However, if some of the dynamic support can be provided by computers and computer networks, then we may be able to recreate these kinds of environments as a central part of our educational system. The kinds of activities described previously (a student newswire, joint science and social science projects, etc.) allow students to become "teleapprentices", with the electronic network providing the setting for students to participate in functional activities with adults, where the simple tasks performed by students can be carried out in a context in which those tasks make sense. By using the computers to provide some of the "dynamic support", students can learn in a "teleapprenticeship" setting, where they learn a subject domain by jointly participating with adults tackling real problems in that domain without putting an excessive burden on those adults.

Summary

In this paper, I've sketched out a set of contexts for learning and development that microcomputers and electronic networks make possible. I have also described some recent explorations of these contexts that are now taking place, which are the joint efforts of adults using these same tools as a context for their learning and the development of these new instructional media. By using these new communication tools, we may be able to tackle some of the hard problems facing us, using these tools to bring different points of view to bear through joint problem solving efforts distributed over the whole earth.

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